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RESEARCH MEMORANDUM

AN INVESTIGATION OF AILERON OSCILLATIONS AT TRANSONIC SPEEDS ON NACA 23012 AND NACA 65-212 AIRFOILS BY THE WING-FLOW METHOD

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

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AN INVESTIGATION OF AILERON OSCILLATIONS AT TRANSONIC SPEEDS ON NACA 23012 AND NACA 65-212 AIRFOILS BY THE WING-FLOW METHOD

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SUMMARY

An investigation is being conducted to determine the feasibility of studying aileron "buzz" by the wing-flow method. Two semispan models which had a taper ratio of 2 and an aspect ratio of 6 with half-span quarter-chord mass-balanced ailerons have been used in this investigation. The ailerons have been unrestrained except for bearing friction. One model had an NACA 23012 airfoil section and the other had an NACA 65-212 airfoil section. The flat-sided aileron on the NACA 23012 airfoil and the cusped aileron on the NACA 65-212 airfoil both were subject to "buzz" over a small range of Mach number near 0.9. The results obtained so far indicate that the wing-flow method may be a valuable tool for the investigation of aileron "buzz."

INTRODUCTION

Aileron "buzz" was encountered with a jet-propelled fighter-type airplane which had an NACA 65_1-213 airfoil section at a Mach number of approximately 0.8. (See reference 1.) In the present paper the term aileron buzz refers to the oscillation of the control surface at supercritical Mach numbers. This oscillation has also been referred to as aileron compressibility flutter. The motion of the ailerons of the airplane of reference 1 at a Mach number of 0.86 was violent enough to damage the aileron structure. It was therefore evident that investigation of aileron buzz in flight was unsafe. An investigation was made with an identical full-scale wing panel in the Ames 16-foot high-speed tunnel. Agreement with flight results was obtained, but the tests were limited to a Mach number of 0.82. The investigation reported herein was undertaken to determine whether or not the wing-flow method would be satisfactory for extending the study of aileron buzz to a Mach number of approximately 1.1.

PROCEDURE

Two wing panels which had a taper ratio of 2 and an aspect ratio of 6 have been used for this investigation. One of the model wings had an NACA 65-212 airfoil section and the other had an NACA 23012 airfoil section. Details of the models are shown in figures 1 and 2.

The quarter-chord ailerons extended over approximately the outer half of the model span. The aileron nose was elliptical with only as much overhang as was required for mass balance weight. The length of the overhang was approximately 18 percent of the aileron chord. Accuracy of construction was not as great for the built-up wooden ailerons as for the metal airfoil. As a result the NACA 65-212 aileron was too thick by approximately 0.03 inch (30 percent) at the inboard end of the aileron on the hinge line and half as much oversize at the tip. The aileron on the NACA 23012 airfoil was only slightly thicker than the adjacent fixed surface, but the hinge line was raised 0.01 inch.

The tests covered a range of Mach numbers from 0.55 to 1.1 which was obtained by diving the wing-flow airplane to $M = 0.73$, the limiting safe speed. In some cases runs were made over two altitude ranges to extend the Reynolds number range. The maximum range of Reynolds numbers was 300,000 to 1,000,000 based on the mean aerodynamic chord. The ailerons were unrestrained except for hinge friction which amounted to 0.01 or 0.02 inch-ounces. In addition to the quantities required for determining Mach number, the angle of attack of the model airfoil and the aileron angle were measured.

RESULTS

Typical examples of the data obtained are presented in figures 3 and 4 which show the variation of aileron angle and angle of attack with Mach number. The Mach number presented in these figures is the average value over the span of the aileron where the maximum spanwise Mach number gradient was 0.007 per inch. These data show that both the cusped aileron on the NACA 65-212 airfoil and the flat-sided aileron on the NACA 23012 airfoil buzz over a small range of Mach numbers near 0.9.

The NACA 23012 aileron buzzed during the low Reynolds number run, whereas the NACA 65-212 aileron did not. A vibration of the record line for the NACA 23012 aileron occurred at Mach numbers from 0.87 down to as low as 0.25. The bearing play was rather large on this model. Reduction of the bearing play considerably reduced the amplitude of the vibration. This vibration disappeared before the buzz range was entered.

The buzz, which was observed on the wing-flow models to start at about M = 0.87 for the NACA 65-212 model and 0.89 for the NACA 23012 model, appears to correspond to the most severe buzz reported in reference 1 which occurred at M = 0.86. The facts that the wing-flow models had a 1-percent-thinner airfoil section and that the lift coefficient was near zero compared to 0.4 in the flight tests both tend to account for this small difference in Mach number. An indication of smaller-amplitude buzzing of the NACA 65-212 model at M = 0.79 was also obtained in the wing-flow tests. In this respect the wing-flow data also agree with reference 1. During the full-scale flight tests the aileron floated up in the Mach number range where buzz occurred, whereas the model aileron floated down. The difference in lift coefficient between the two sets of tests was in the direction which would tend to produce a less upward floating angle of the model.

One set of runs was made with the hinge friction of one of the wing-flow models increased several hundred percent. There was no noticeable change in the buzz characteristics of the aileron.

Measurements were also made with solid dural ailerons having no mass balance. These ailerons were subject to large-amplitude (±100°) oscillations over a large part of the test Mach number range. This oscillation was believed to be conventional flutter.

CONCLUSIONS

1. These tests indicate that the wing-flow method may be a valuable tool for the investigation of aileron buzz.

2. The ailerons on the NACA 23012 and NACA 65-212 airfoil models were subject to buzz over a small range of Mach number near 0.9.

3. The data obtained from wing-flow tests agreed reasonably well with full-scale flight results.

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REFERENCE

1. Brown, Harvey H., Rathert, George A., Jr., and Clousing, Lawrence A.: Flight-Test Measurements of Aileron Control Surface Behavior at Supercritical Mach Numbers. NACA RM No. A7A15, 1947.

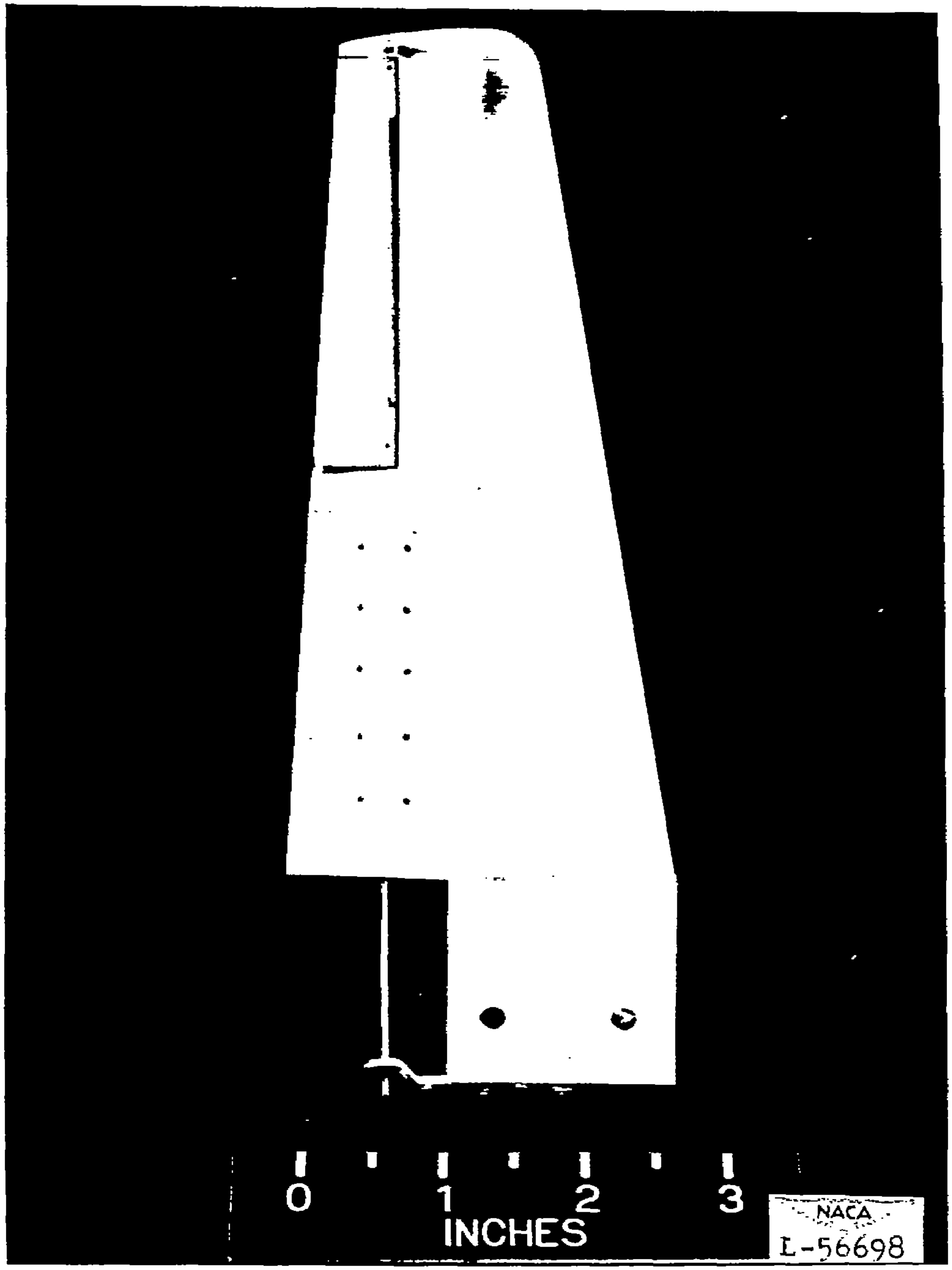

Figure 1.– Photograph of wing-flow model used for investigating aileron buzz.

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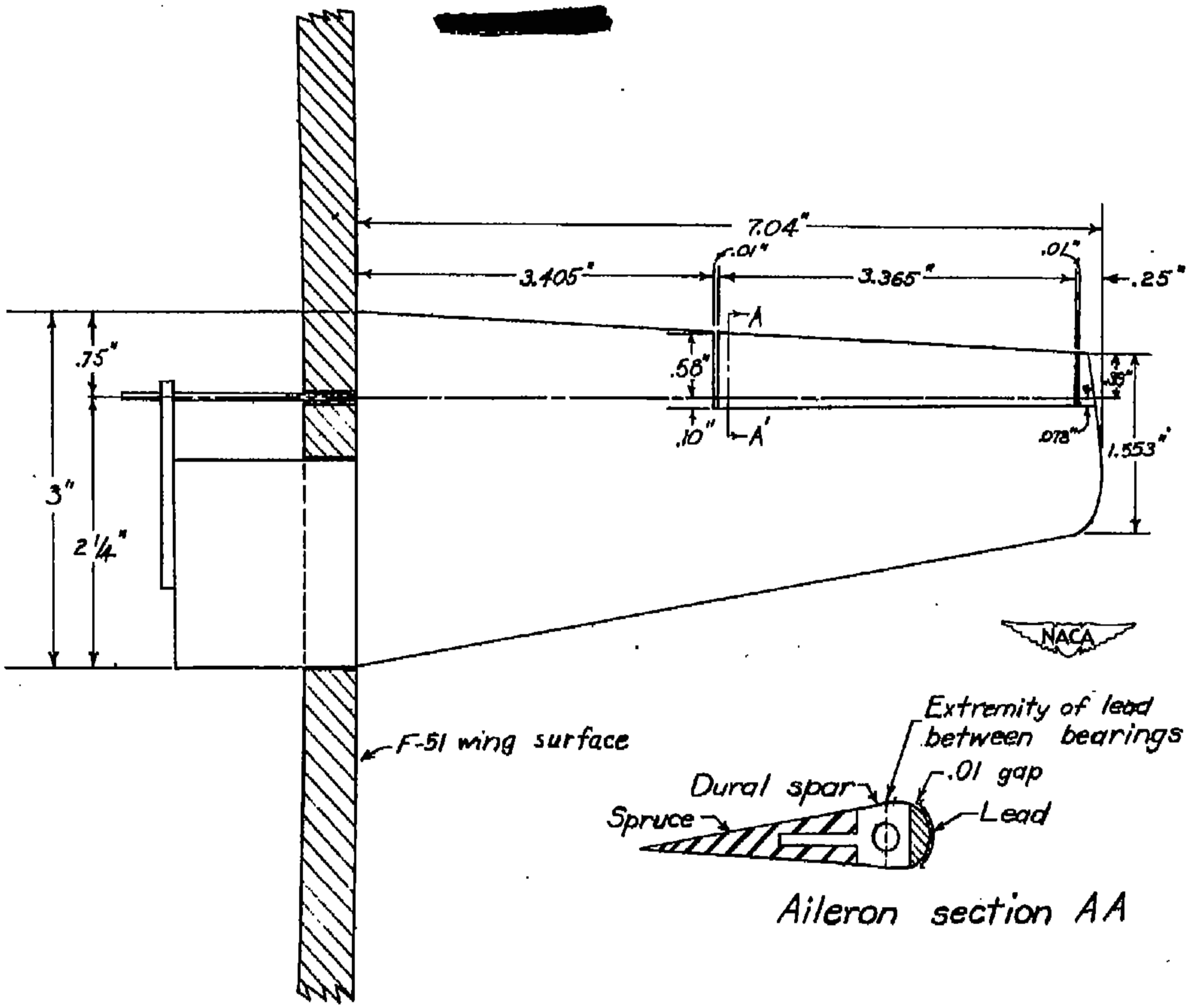

Figure 2.– Sketch of aileron buzz model.

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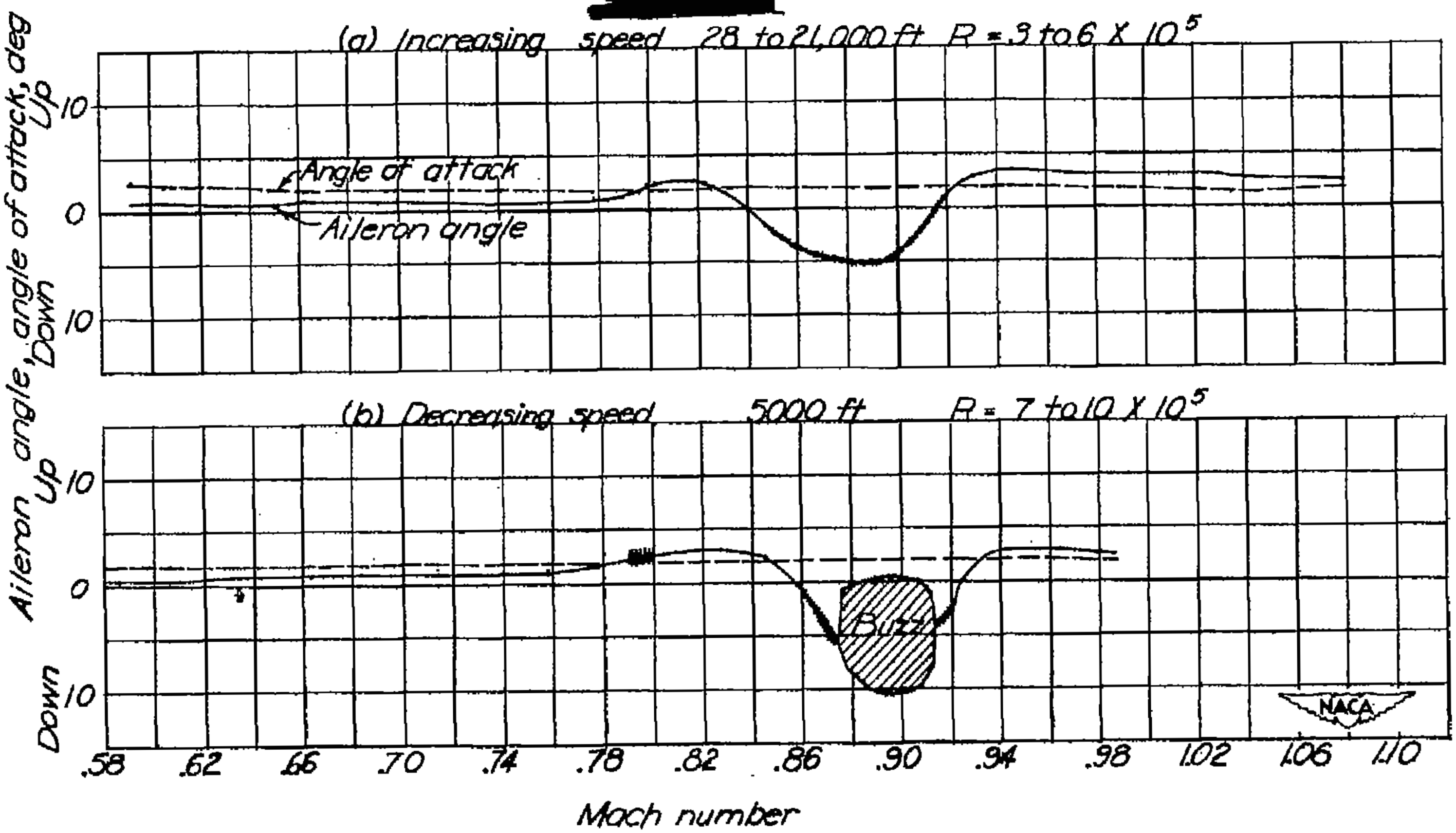

Figure 3.– Aileron angle as a function of Mach number for the NACA 65–212 buzz model.

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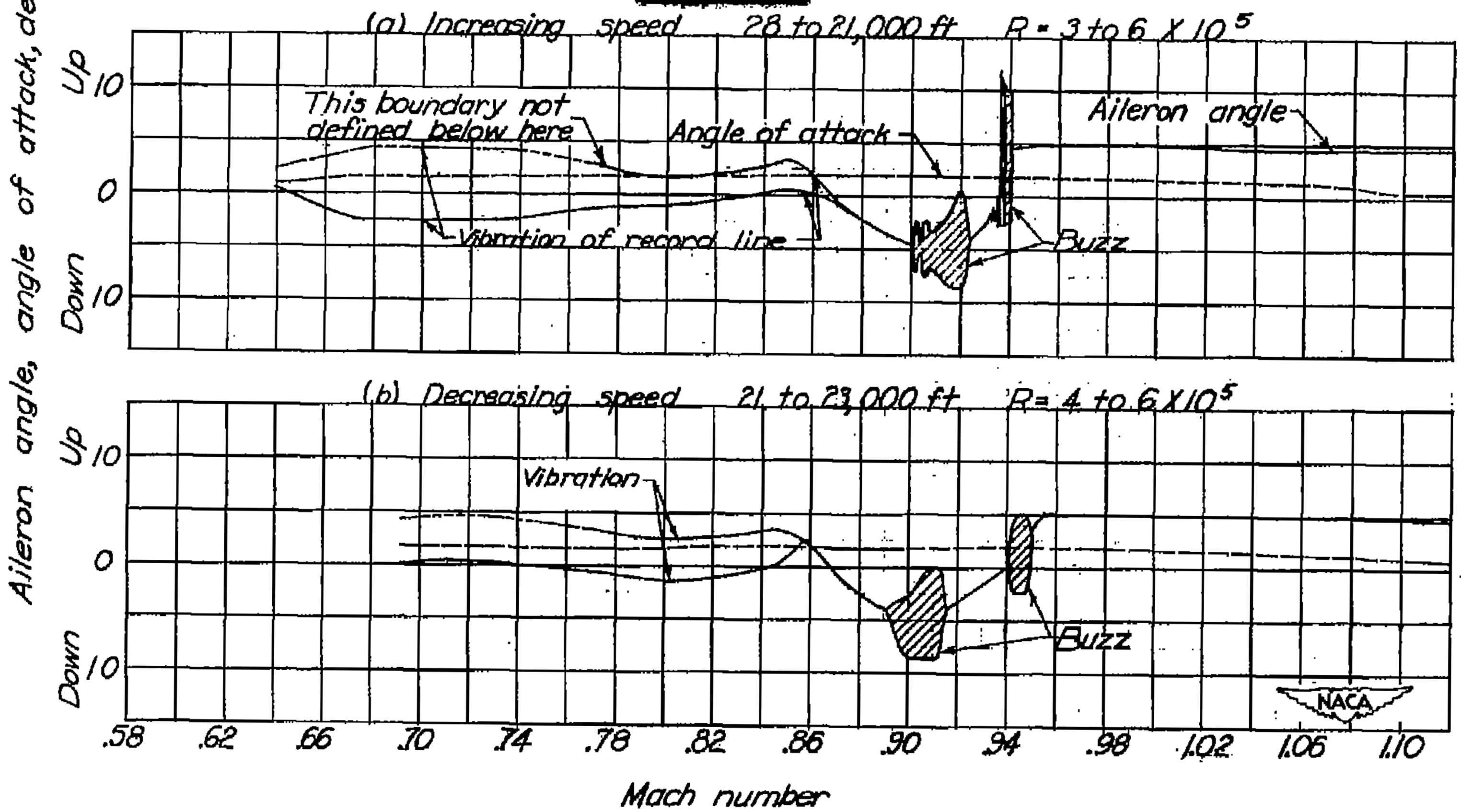

Figure 4.– Aileron angle as a function of Mach number for the NACA 23012 buzz model.

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